

Engineering With Nature for Sustainable and Resilient Water Resources Infrastructure



Cynthia J. Banks

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Engineer Research and Development Center

UK Environment Agency
28 July 2015



®

US Army Corps of Engineers
BUILDING STRONG®

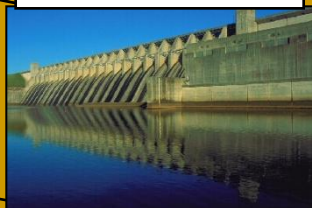


USACE Civil Works Value to the Nation

**Recreation areas:
370 M Visitors/yr
Generate \$16B in
economic activity,
270,000 jobs**



**¼ of Nation's
Hydropower:
\$1.5B + in
power sales**



**12,000 miles of
Commercial Inland
Waterways
transport goods at
½ the cost of rail or
1/10 the cost of
trucks**



**926 Shallow &
Deep Draft
Harbors**



**#1 Federal Provider
Of Outdoor Recreation
54,879 Miles Of Shoreline
at USACE Lakes**



**Stewardship of
12 Million Acres
Public Lands**



**~14,500 Miles of
Levees**



**Emergency
Operations**



**Regulatory
Responsibilities**

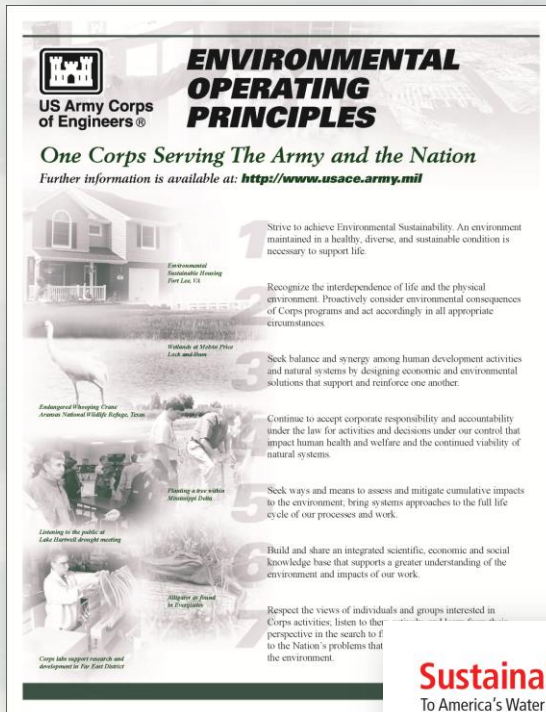


**137 Major Environmental
Restoration Projects**

**Ports & Waterways Convey > 2.37 billion Tons Commerce
Ports Provide Strategic Deployment Capability
Harbor Maintenance Trust Fund collects \$1.7 billion revenue**



Advancing USACE Practice



Goals:

- More efficient, cost effective engineering and operational practices.
- More collaboration and cooperation, less unproductive conflict.
- Sustainable projects. Triple-win outcomes integrating social, environmental and economic objectives.

Vision: "Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation's water resources challenges."

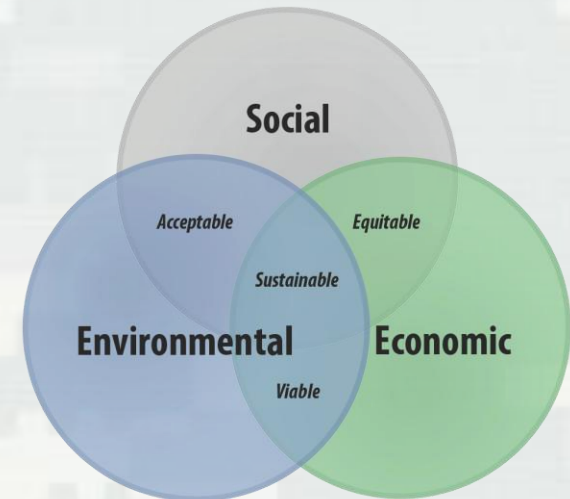


Engineering With Nature...

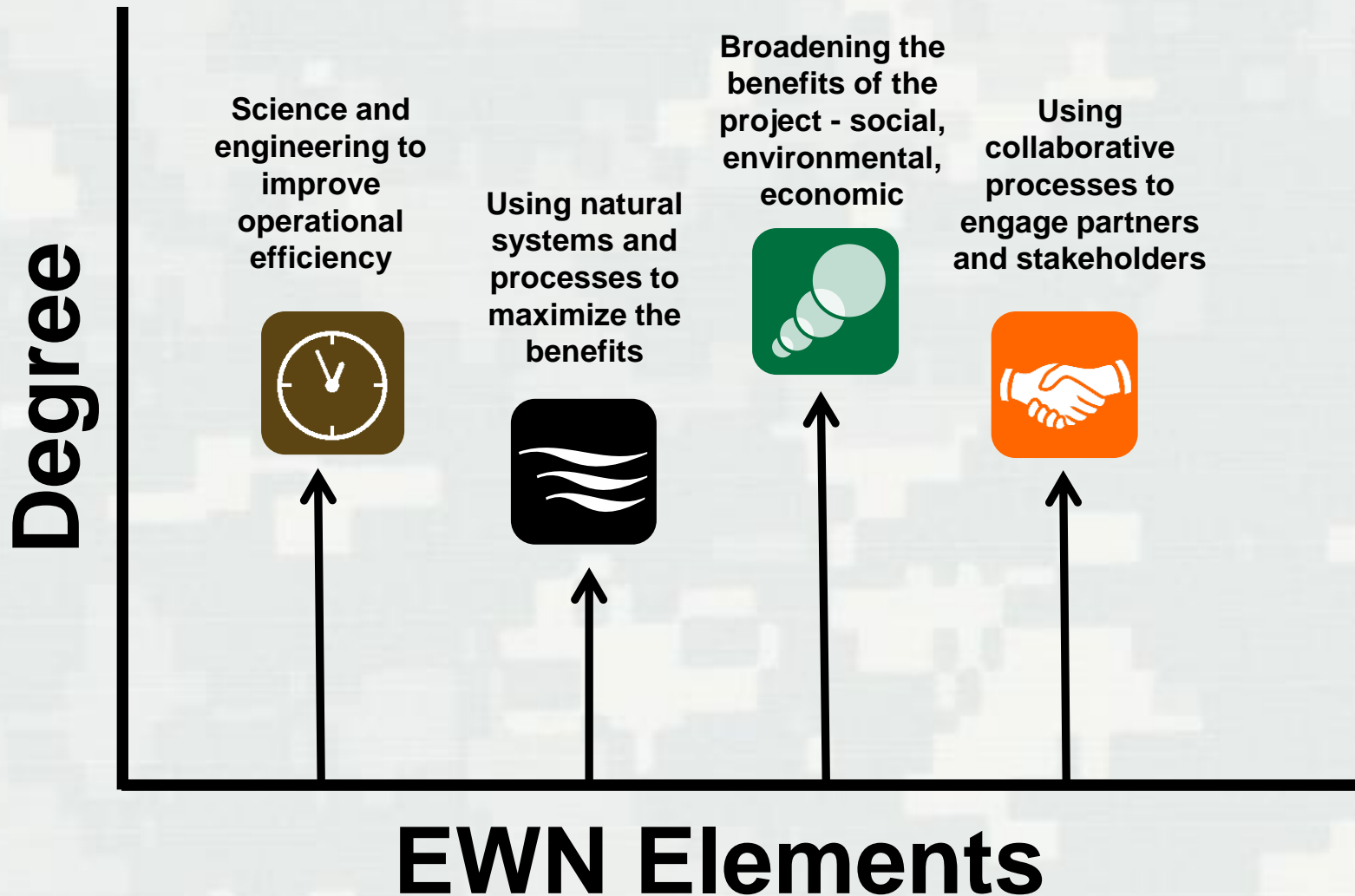
...the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaborative processes.

Key Elements:

- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners



Engineering With Nature Elements



Case Study #1

- Evia Island (Galveston Bay, TX)
- 6-acre island was constructed using sediment dredged during the deepening of the Houston Ship Channel in 1998
- Birds making use of habitat provided by the island
- Producing significant environmental benefits



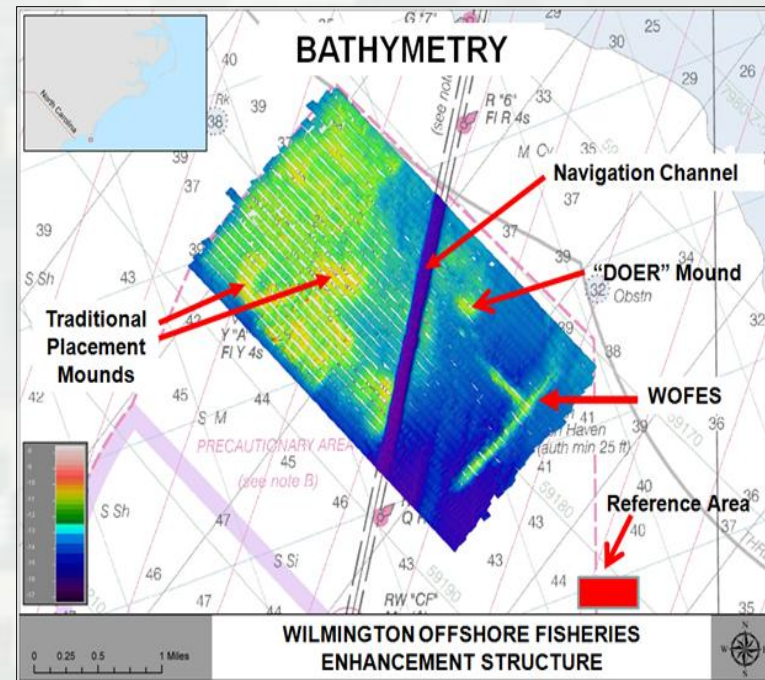
Case Study #2

- Horseshoe Bend Island Creation along the Atchafalaya River (Morgan City, LA)
- As placement sites continue to become exhausted, there was a need for more creative placement alternatives in the Gulf Coast.
- In 2002, strategic placement of the sediment dredged from Horseshoe Bend occurred at the mid-river open water placement area.
- Strategic placement of between 0.5 to 1.8 million cubic yards of sediment was conducted every 1-3 years developing an ~35 ha island mid-river.
- Producing significant environmental and economic benefits



Case Study #3

- Wilmington Offshore Fisheries Enhancement Structure (Wilmington, NC)
- Created in 1994-1997 from 764,600 cubic meters of limestone dredged as part of the Wilmington channel deepening
- Located three nautical miles off of the mouth of the Cape Fear River in North Carolina
- The location and design of the reef involved extensive participation by stakeholders, and the North Carolina Department of Environment and Natural Resources supported the project as a local sponsor.
- Produced significant social benefits as a popular destination for fishing tournament participants



EWN Status

- *Engineering With Nature* initiative started within USACE Civil Works program in 2010. Over that period, we have:
 - ▶ Engaged across USACE Districts (23), Divisions, HQ; other agencies, NGOs, academia, private sector, international collaborators
 - Workshops (>20), dialogue sessions, project development teams, etc.
 - ▶ Implementing strategic plan
 - ▶ Focused research projects on EWN
 - ▶ Field demonstration projects
 - ▶ Communication plan
 - ▶ Awards
 - 2013 Chief of Engineers Environmental Award in Natural Resources Conservation
 - 2014 USACE National Award-Green Innovation
 - 2015 Western Dredging Association Environmental Excellence Award



Hurricane Sandy

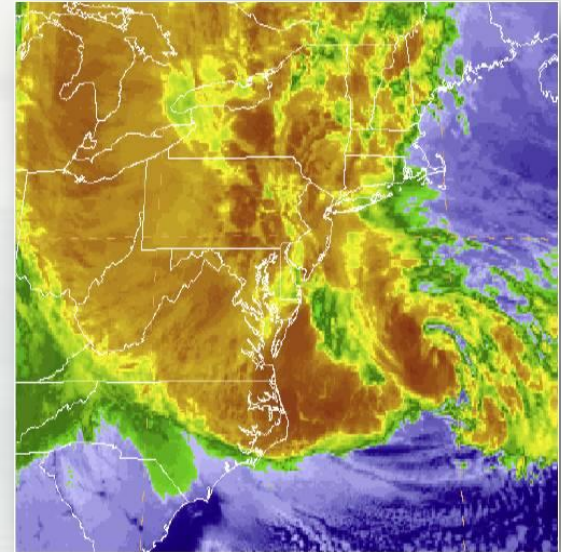
Storm Impacts and Damages:

► Human

- 286 people killed (159 in the US)
- 500,000 people affected by mandatory evacuations
- 20,000 people required temporary shelter
- Extensive community dislocations – continuing today in some areas

► Economic

- \$65B in damages in the U.S.
- 26 states affected (10 states and D.C are in the NACCS study area)
- 650,000 houses damaged or destroyed



In the Context of Coastal Resilience...

- What opportunities are there for achieving better alignment of natural and engineered systems?
 - ▶ Can improved alignment reduce risks to life and property?
 - ▶ What range of services can be produced through such alignment?
 - ▶ What are the science and engineering needs in order to achieve better alignment?

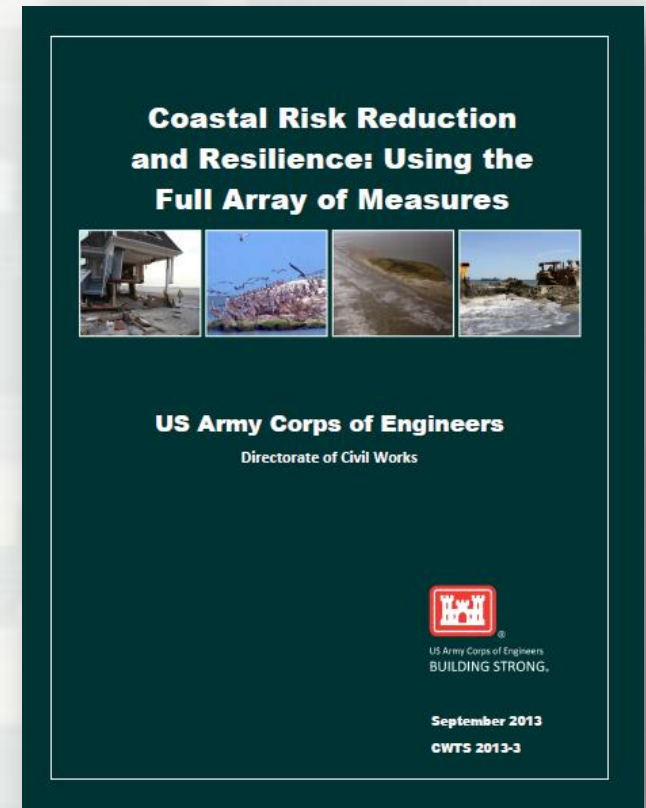


Sustainable Solutions Vision: “Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation’s water resources challenges.”



Systems: Coastal Risk Reduction and Resilience

*“The USACE planning approach supports an **integrated approach** to reducing coastal risks and increasing human and ecosystem community resilience through a combination of **natural, nature-based, non-structural and structural measures**. This approach considers the engineering attributes of the component features and the dependencies and interactions among these features over both the short- and long-term. It also considers the **full range of environmental and social benefits** produced by the component features.”*



Natural and Nature-Based Infrastructure at a Glance

GENERAL COASTAL RISK REDUCTION PERFORMANCE FACTORS:
STORM INTENSITY, TRACK, AND FORWARD SPEED, AND SURROUNDING LOCAL BATHYMETRY AND TOPOGRAPHY



Dunes and Beaches

Benefits/Processes

Break offshore waves
Attenuate wave energy
Slow inland water transfer

Performance Factors

Berm height and width
Beach Slope
Sediment grain size and supply
Dune height, crest, width
Presence of vegetation



Vegetated Features:

Salt Marshes, Wetlands, Submerged Aquatic Vegetation (SAV)

Benefits/Processes

Break offshore waves
Attenuate wave energy
Slow inland water transfer
Increase infiltration

Performance Factors

Marsh, wetland, or SAV elevation and continuity
Vegetation type and density



Oyster and Coral Reefs

Benefits/Processes

Break offshore waves
Attenuate wave energy
Slow inland water transfer

Performance Factors

Reef width, elevation and roughness



Barrier Islands

Benefits/Processes

Wave attenuation and/or dissipation
Sediment stabilization

Performance Factors

Island elevation, length, and width
Land cover
Breach susceptibility
Proximity to mainland shore



Maritime Forests/Shrub Communities

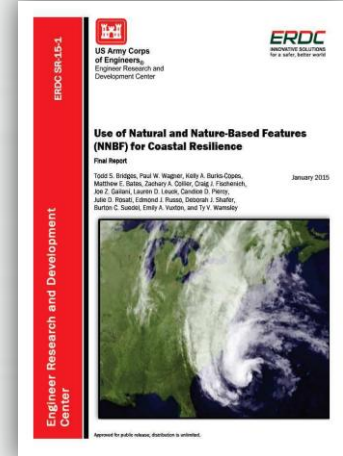
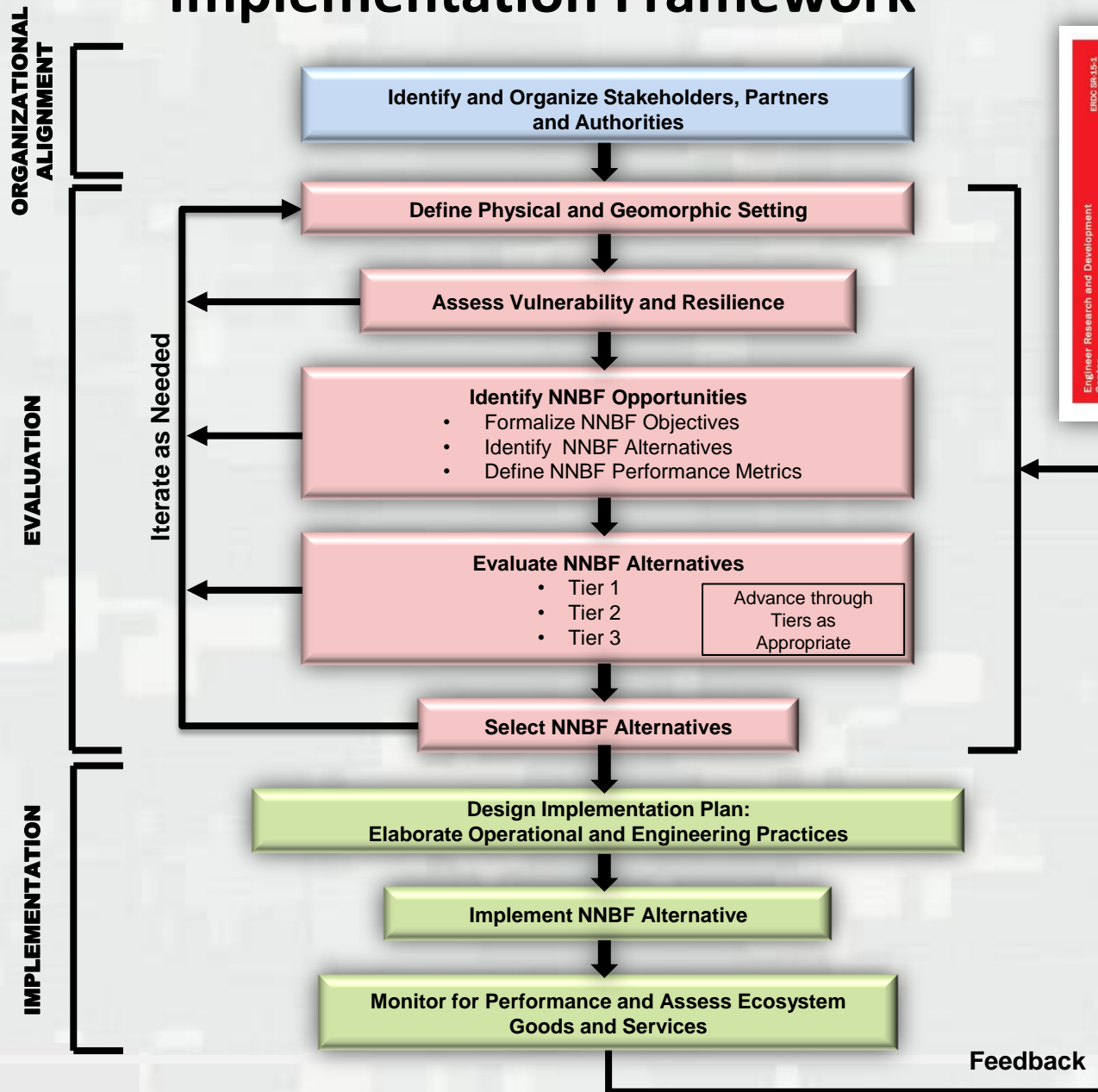
Benefits/Processes

Wave attenuation and/or dissipation
Shoreline erosion stabilization
Soil retention

Performance Factors

Vegetation height and density
Forest dimension
Sediment composition
Platform elevation

Natural and Nature-Based Features Evaluation and Implementation Framework



Coastal Resilience: The Environment, Infrastructure, and Human Systems

- USACE was the primary sponsor and host (USEPA and USDOE were co-sponsors)
 - ▶ Dr. Todd Bridges, Conference Chair
 - ▶ Ms. Cynthia Banks, Conference Organizer
- 85 participants from 8 countries (Barbados, Fiji, Mexico, The Netherlands, South Africa, South Korea, United Kingdom, and United States)
 - ▶ Diversity of organizational perspectives:
 - USACE, NOAA, USEPA, USFWS, OMB, CEQ, DOE, US Navy, Treasury Department, State Department, TNC, AAPA, Water Institute of the Gulf, National Wildlife Federation, Great Lakes Dredge & Dock Company, Environ Corp., Dewberry, several universities, and many other organizations
- Conference consisted of a series of plenary presentations and panel discussions
 - ▶ Share information about science and engineering relevant to coastal resilience



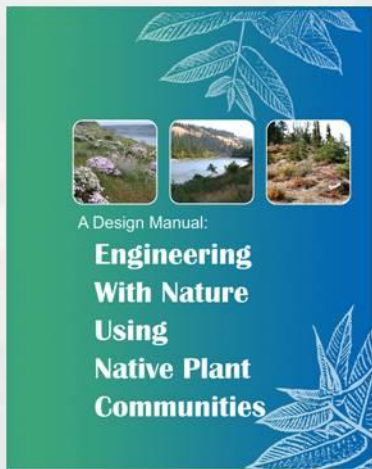
The audio and visuals for each presentation are at:
<http://el.erdcc.usace.army.mil/ewn/workshop.cfm?List=14MayCR>

ERDC

Communication

wetland science practice

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A Design Manual: Engineering With Nature Using Native Plant Communities

Authored by:
Dr. Pamela
U.S. Army
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Sponsored by:
Engineering
U.S. Army



T.S. BRIDGES, J. LILLYCROP, J.R. WILSON, T.J. FREDETTE, B. SUEDEL, C.J.



Technical Articles

Dedicated to the USA, Host Country of PIANC's AGA 2014
and the 33rd PIANC World Congress

ERDC environmental research supports USACE civil

By Dr. Beth Fleming
Director, Environmental Laboratory
U.S. Army Engineer Research and
Development Center

A U.S. Army Engineer Research and Development Center (ERDC) Environmental Laboratory (EL) scientist and engineer work to develop sustainable solutions to the nation's civil and military environmental challenges. Researchers understand that solutions developed for civil works challenges can be leveraged to solve military challenges and vice versa. This transboundary approach allows EL to focus on durable results for customers that balance social, economic and environmental factors as part of a sustainable solution.

ERDC's scientific expertise in environmental research and the use and decision analysis unique within the Army and Department of Defense. We are committed to sharing the application of these capabilities in a related way and demonstrating the environmental impact, risks, benefits and sustainability of new technologies and materials in all of our work initiatives. These work initiatives are the focus of this column. Environmental Life Cycle Assessment—an early initiative that will provide a comprehensive view of the environmental impacts from the development, production, use and disposal of Army materials and products. Green Remediation Technologies—an initiative in the prototype phase that focuses on minimizing the migration of materials, and engineering with nature—a nature initiative that aligns natural and engineering processes to gain economic, environmental and social benefits.

Environmental life cycle assessment (ELCA) seeks to institutionalize a practice that will institutionalize environmental data associated with new materials, processes and technologies, and provides a way to

improve the sustainability of existing activities such as dredging. This initiative, while in its introductory stage, is already proving valuable to both the civil works and military missions communities. The U.S. Army Corps of Engineers, through its disintegrated activities, is responsible for the placement of approximately 250 million cubic yards of dredged material in the annual call of more than \$1.2 billion. EL is introducing an ELCA approach that the dredged material management process as a way to understand and consistently compare alternatives by quantifying ecosystem benefits, human health and resource consumption.

In the placement of dredged material, the life cycle assessment captures the environmental impacts of extracting raw materials from the earth, the production of equipment and materials needed to handle and transport dredged material and construct a disposal site, and the shipping process to produce the final needed and the subsequent final contribution.

Life cycle assessment can also quantify the ecosystem benefits associated with creating new habitat through dredged material placement, allowing more consistent input in the decision process. The benefits of this important effort, the Army Environmental Life-Cycle Manual for Acquisition and Contracting, is a life cycle assessment that includes a scientifically defensible approach for quantifying the environmental life cycle assessment in acquiring product and technology input with respect to environmental regulatory requirements when selecting, designing, Army facility and improved facility safety and

sustainability of current and future related technologies. For more on environmental ELCA, contact Amy Barham, associate technical director for Environmental Quality/Infrastructure (EQI), at Amy.Barham@usace.army.mil.

Green remediation technologies for remediation management. EL researchers are working closely with the range community to test prototype green remediation technologies to reduce the concentration of military contaminants (MC) in the environment. These new tools will allow large managers increased flexibility in incorporating large impact areas and decrease the risk of a remediation project by reducing a remediation project's environmental impacts.

EL is also working on a new initiative to update the environmental regulatory guidelines related to MC migration off-site in surface and ground water, as well as potential uptake into ecological systems.

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Inland Port

2011 Issue VI

USACE Promotes Environmental Sustainability



Panama Canal Impact Projections

Ports Must Promote PIANC and IRPT



TME The Military Engineer

Maj. Gen. John Peabody on the Future of Civil Works Page 44

The Restoration of Fort Ord Page 63

How the Air Force

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2014 EDITION

"ENGINEERING WITH NATURE" PROMOTES TRIPLE-WIN OUTCOMES

ABSTRACT

The U.S. Army Corps of Engineers' "Engineering With Nature" (EWN) initiative supports sustainable development of infrastructure by advancing technical and communication practices in order to intentionally align natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaborative processes. The tools and projects that have been developed through EWN support planning, engineering, and operational practices that benefitably integrate engineering and natural systems to produce more socially acceptable, economically viable, and environmentally sustainable projects.

The EWN initiative's focus on developing practical methods provides an achievable path toward an ecosystem approach to navigation infrastructure development. By combining sound science and engineering with advanced communication practices, the EWN initiative is providing a robust foundation for collaborative project development. Engineering With Nature is being pursued through innovative research, field demonstrations, communicating lessons learned, and active engagement with field practitioners across a wide range of organizations. The objectives of EWN are consistent with those communicated in the

"Working with Nature" philosophy of the World Association for Waterborne Transport Infrastructure (PIANC) and the "Building with Nature" initiative of Ecotopia Foundation, a public-private knowledge institute in the Netherlands.

INTRODUCTION

Pursuing the objective of sustainable development of navigation infrastructure poses both challenges and opportunities for the U.S. Army Corps of Engineers (USACE). Advancing best practices will involve identifying the practical actions that can be taken to better align and integrate engineering and natural systems to produce more socially acceptable, economically viable and environmentally sustainable projects. Engineering With Nature (EWN) is a USACE initiative that supports more sustainable practices, projects, and outcomes by working with nature to deliver sustainable projects. Engineering With Nature (EWN) is a USACE initiative that supports more sustainable practices, projects, and outcomes by working with nature to deliver sustainable projects.

Below: Aerial photo of the wetlands at the Mississippi River Gulf Outlet near New Orleans in November 2013 as the project nears completion.

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Science, engineering and design projects within the EWN initiative use of: 1) science and engineering to operational efficiencies and 2) natural processes to maintain themselves reducing demands resources, minimizing the footprint of projects, and a quality of project benefits. 3) approaches that will broaden the base of benefits provided includes substantiated economic, environmental and social benefits. 4) approaches that will broaden the base of benefits provided includes substantiated economic, environmental and social benefits. 5) approaches that will broaden the base of benefits provided includes substantiated economic, environmental and social benefits.

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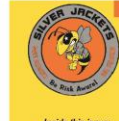
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The BUZZ

The BUZZ is a forum for ideas, news, information, and resources.

Yazmin Seda-Sanabria Appointed Acting Deputy Chief USACE Office of Homeland Security

By Kate Noland, USACE HR

The USACE Office of Homeland Security (OHS) is pleased to welcome Yazmin Seda-Sanabria as its acting deputy chief. Ms. Seda-Sanabria is an emergency management for the next three months. She will oversee matters related to Flood Risk Management, Emergency Management, and Critical Infrastructure Protection and Resilience. Ms. Seda-Sanabria is the national program manager of the Office of Homeland Security's Critical Infrastructure Protection and Resilience Program (USACE Headquarters). In this role, she provides oversight for program development, execution, and implementation of risk management strategies for enhancing the security of USACE's critical infrastructure projects.

In 1994, Ms. Seda-Sanabria joined the U.S. Army Engineer Waterways Experiment Station - now U.S. Army Engineer Research and Development Center (ERDC)—as a research structural engineer in the Geotechnical

and Structures Division, Geotechnical and Structures Laboratory. While at ERDC, she was involved in multiple research and development programs related to analysis and design of concrete hydraulic structures, as well as rapid load capacity assessment of bridges. She joined USACE Headquarters in 2006 as the Executive Director and Management, general expenses program manager in the Civil Works Program Integration Division. In 2007, Ms. Seda-Sanabria joined the Office of Homeland Security in her current position.

Ms. Seda-Sanabria holds a bachelor's degree and master's degree in Civil Engineering from the University of Puerto Rico at Mayaguez. She earned a Master of Science degree in Engineering Mechanics from Mississippi State University. In 1996, she received the American Society of Civil Engineers' Young Government Civil Engineer National Award in recognition of her public and professional service achievements. In 2002,

she received the Woman of Color Government and Defense Award for Technical Innovation in recognition for her efforts leading to the development and implementation of innovative technologies for rapid load capacity assessment of bridges. She has authored more than 30 publications, including peer-reviewed journal and conference papers, invited articles, and technical reports. She is a member of various professional engineering organizations, including the American Society of Civil Engineers, the Association of State Dam Safety Officials, the U.S. Society on Dams, and the Sigma Xi Research Society.

Her to support the Great Lakes Restoration Initiative, which was awarded a Working With Nature Certificate

and the nation. We are committed to providing innovative solutions for a safer, better world.

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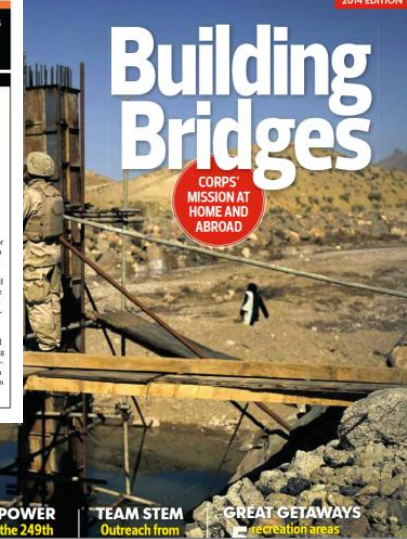
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CORPS' MISSION AT HOME AND ABROAD

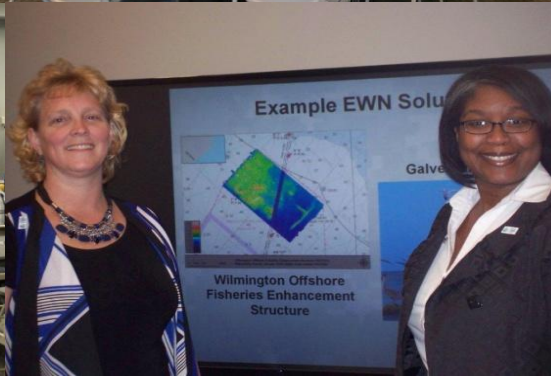
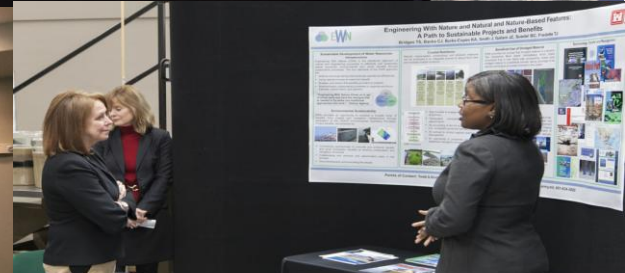
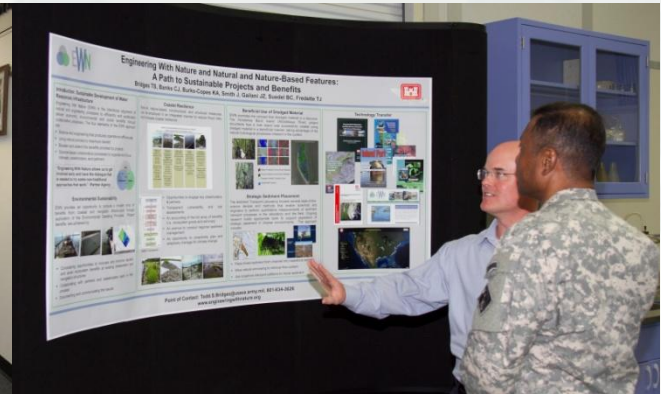
CORPS VS. NATURE
Climate change creates

PRIME POWER
Profile of the 249th

TEAM STEM
Outreach from

GREAT GETAWAYS
recreation areas

Engagement and Solution Co-Development



2013 EWN Action Demonstration Projects

- Sediment Retention Engineering to Facilitate Wetland Development (San Francisco Bay, CA)
- Realizing a Triple Win in the Desert: Systems-level Engineering With Nature on the Rio Grande (Albuquerque, NM)
- Atchafalaya River Island and Wetlands Creation Through Strategic Sediment Placement (Morgan City, LA)
- Portfolio Framework to Quantify Beneficial Use of Dredged Material (New Orleans and New England)
- Engineering Tern Habitat into the Ashtabula Breakwater (Ashtabula, OH)
- Living Shoreline Creation Through Beneficial Use of Dredged Material (Duluth, MN)
- A Sustainable Design Manual for Engineering With Nature Using Native Plant Communities



2014 EWN Action Demonstration Projects

- Landscape Evolution of the Oil Spill Mitigation Sand Berm in the Chandeleur Islands, Louisiana
- Guidelines for Planning, Design, Placement and Maintenance of Large Wood in Rivers: Restoring Process and Function (Collaboration with BoR)
- The Use and Value of Levee Setbacks in Support of Flood Risk Management, Navigation and Environmental Services (a strategy document)
- Strategic Placement of Sediment for Engineering and Environmental Benefit (an initial guide to opportunities and practices)



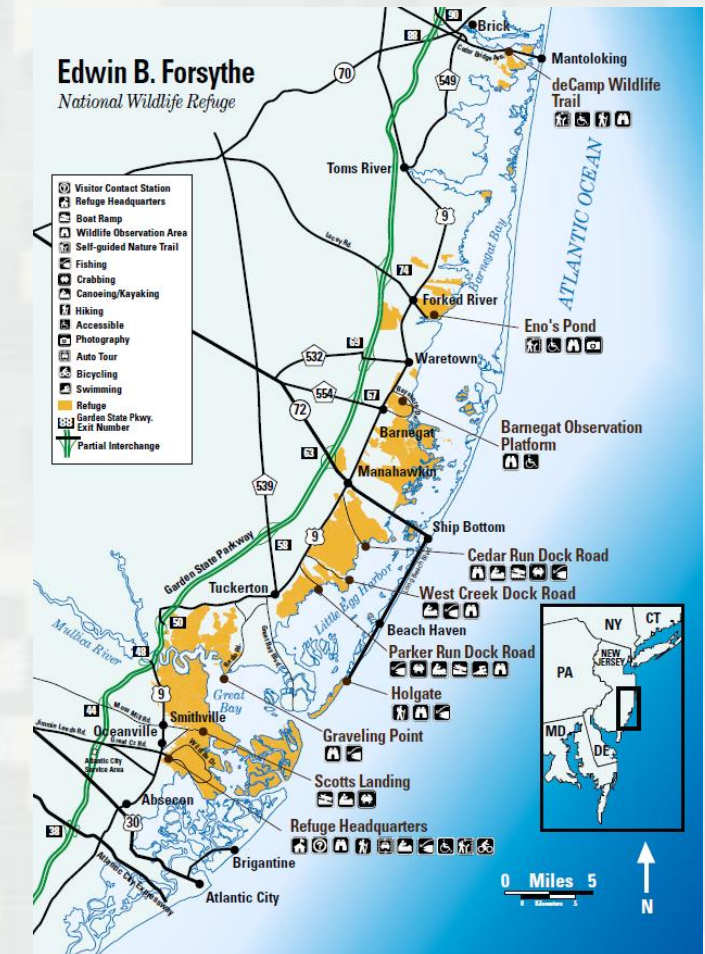
USACE *Engineering With Nature* Across USACE

- Collaborating with Philadelphia, Detroit, San Francisco, New Orleans Districts on using sediment to enhance coastal resilience
- Galveston and Buffalo Districts serving as “proving grounds” for district-wide integration of EWN principles and practices



Forsythe National Wildlife Refuge

- Forsythe NWR:
>40,000 acres of wetlands and other habitat in coastal NJ
- Objective: Enhance ecosystem resilience through engineering and restoration
- Means: Apply EWN principles and practices



Science, Engineering, Technology Research Targets

- Advance understanding of important, fundamental processes
 - ▶ E.g., sediment transport through wetlands, environmental goods and services provided by engineered features, engineering performance of NNBF
- Improved modeling systems that engage users, stakeholders and decision-makers
 - ▶ E.g., rapidly deployed, visual interfaces to engage stakeholders in the process, amenable to “what if” evaluation
- Reliable, cost-efficient monitoring technologies for measuring system evolution and infrastructure/feature performance
- Demonstration/pilot project opportunities to innovate, evaluate, and learn at relevant field scales
 - ▶ Facilitating necessary collaboration
 - ▶ Evolving organizational culture and practice
 - ▶ Producing credible evidence of success



Creating Value by Engineering With Nature

- Value arguments resonate
- Moderate the hyper-focus on environmental risks/impacts from conventional infrastructure
 - ▶ NNBF can produce multiple benefit streams
 - ▶ There are potentially valuable allies in “unlikely” places
- Need for complementing sustainability policies with education and research

